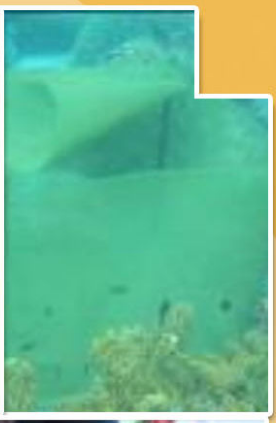
National Fish and Wildlife Foundation

Final Programmatic Report


Project Name and Number: **Coral Reef Fish Rehabilitation in the Philippines (2006-0090-020)**
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REEF CHECK

National Fish and Wildlife Foundation
Dedicated to the conservation of fish, wildlife and plants, and the habitats on which they depend.

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SUMMARY

Reef Check Conservation Program, Inc. has been working with the municipality of Tubigon of Bohol province in the Philippines in coordination with local fishers and established a functional fish farm, collected post larvae fish, reared them and restocked these fishes in two Marine Protected Areas within Tubigon. Local fishers were trained in Reef Check monitoring, which the local government will commission to continue with their reef monitoring. A full assessment of the data prior to and after the restocking is in progress. Partial results will be presented in the forthcoming European Union MPA symposium (www.mpasymposium2007.eu) and a scientific paper is also being prepared for the Journal of Fisheries Management and Ecology.

INTRODUCTION

The coral reefs in Southeast Asia are the most biologically diverse and productive reef systems in the world (Tun et al, 2004). The Philippines is an archipelagic state with over 2.2 million sq. km. of highly productive seas. However, it has been identified by IUCN as one of the 25 "hot spots" in terms of biodiversity losses. Philippine fisheries have been widely documented as over-fished and in poor condition (Green et al., 2005). Research conducted by the World Fish Center in 1998-2001 found that overall, "the level of fishing in the grossly modified stock (in the Philippines) is 30% higher than it should be".

One of the solutions to the problem of over-fishing is the creation of Marine Protected Areas (MPAs), but standing fish stocks are so low in most areas that natural recruitment rates are very slow so that MPAs may take many years to recover, up to 20 years (Russ and Alcala, 2004). This in turn slows the ability of MPAs to serve as seed-beds for surrounding fisheries through the "spillover" effect. In order to boost the role of MPAs to increase fish stocks, we successfully tested a restocking strategy using post-larvae fish collected in the open sea, raised for a few months in a land-based hatchery, and subsequently released into MPAs. By increasing the survival of very young fish in this way, stocks will be increased much more quickly than through natural recruitment.

The municipality of Tubigon is now in a position to move towards more proactive resource rehabilitation using this proven post-larvae collection technology. The town has instituted a coastal management plan and has several MPAs established with strong coastal law enforcement. Despite the excellent quality of its coastal management, the town's resource rehabilitation through natural recruitment has been poor when compared to other areas in the country, and other well-publicized Philippine MPA success stories such as at Apo Island (White and Vogt, 2000).

The objective of this project is to boost the rehabilitation activities of the municipality through post-larvae fish collection, rearing and restocking. This is part of the overall integration of a series of active short-term rehabilitation activities, and will form part of the five year evaluation of Tubigon's coastal resource management plan. Once the demonstration site has been established in Tubigon, it will serve as a training center for other municipalities. The conservation needs are urgent as Philippine coral reefs are in a very poor state (White and Vogt, 2000).

Despite major improvements in coastal management planning, and the setting up of over 700 community-based marine sanctuaries in the Philippines, the actual improvements seen on the associated reefs are, except for a few cases, fairly poor. Therefore, fisheries and coral reefs of the country are still under great threat and declining in health (Philreefs, 2005). The rehabilitation activities proposed will contribute significantly to establishing a simple yet replicable system for rehabilitation that is urgently needed in the Philippines. By focusing on the lowest decision-making layer of management authority in

the country, the municipal Local Government Unit, the project will ensure that popularly mandated local managers with strong grass-roots support will be in overall charge of the technology.

In summary, negative impacts are minimized as the project just "borrows" existing larvae from the system and restores them back at a larger size. The project also brings a further conservation benefit in addition to the restocking benefits, i.e., an alternative livelihood is provided for fishers that in turn reduce pressure on the MPA and neighboring reefs. And finally, the technology is appropriate, as it has been designed and successfully tested for implementation at the village level, with more than 30 species collected, grown and used for restocking to date.

The project aimed at establishing a mini-fish farm as base of operations for post-larvae fish collection and restocking, with trained staff, technicians and fishers, to achieve the following:

1. Research how to best grow and release fishes to enhance recovery of MPAs, using judicious experimental design.
2. Improve the post-larvae rehabilitation model and package the technology in a transferable and replicable manner, to ensure community adoption.
3. Transfer the technology to local institutions and fishers to establish and run a locally constructed and owned fish farm.
4. Release at least 10,000 fishes (50 plus species) in MPAs in Tubigon, Bohol, as part of a restocking program to improve fish biomass and biodiversity.
5. Monitor restocking activities until local fishers are familiar with all technologies involved.
6. Write a peer-reviewed paper on collection of post-larvae fish in the Philippines and present the results at ITMEMS 3 (or similar conference).

METHODS AND ACTIVITIES

The project began with forming the project management steering committee and the drafting of a legal document, the Memorandum of Understanding, between the project implementation partners, Reef Check, the Local Government Unit of Tubigon and Feed The Children Philippines, Inc., which was signed during the regular meeting of the Tubigon legislative council (Sangguniang Bayan) in late 2006. A project stakeholders' meeting was then conducted to plan out the various initiatives of the project and to secure project implementation counterparts (human and financial) for the implementation. Once the legal permits and administrative requirements were ascertained the collection of fish began.

Fish collection

Ecocean Inc. has designed a system which catches post larvae fish and does not harm or damage the captured fish or any other organism in the collection area. The collection is done using a light trap called CARE (Collection by Artificial Reef Eco-friendly) patented by Ecocean.

Photo showing Reef Check staff holding CARE equipment

Photo showing local fisher with CARE fish trap

Photo showing CARE light being prepared for submersion

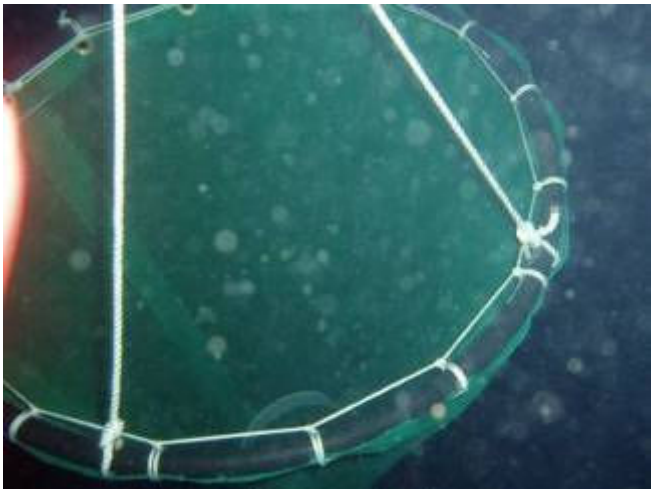


Photo showing CARE trap under water

Photo showing CARE light under water

Retrieving post-larval fish from the CARE trap is relatively easy, which are transferred to the land-based facility for sorting. Village fishermen were trained to carry out all the work needed. Trainings were completed and a total of three local fishers are now capable of managing the collection of the fish. Fish were collected from three different sites in Tubigon waters with mooring buoys demarcating the collection areas.

Photo showing Mooring buoy established
with Pangapasan Island in the background

Initially, the collection was poor with an average of 12 post larvae per CARE trap per night, which is very low when compared to Fiji (average of 45). To alleviate the problem of low catch with the CARE traps, a new fishing device was introduced by the project team, the lift net (*sapyaw*) type of fishing which would increase the collection of fish.

Alternative fishing device

The *sapyaw* is basically a modified lift net fishing gear, with a special light above the boat to attract the post larvae. At regular intervals the fish net is lifted and post larvae collected. Every 15 minutes the net was taken out of the water to count what was captured. An average of one post larva per lift was collected. This was tried for several nights and despite the active type of fishing, there was no significant increase in the number of fish collected. The steering committee decided to keep the gear until post larvae numbers increased, which unfortunately did not happen during the project life. The lift net has the disadvantage that the fisher operator must stay awake for the whole operation at night. Its primary advantage is that it is very cheap and easy to set and handle but as catches with it were low, it was only used occasionally.

Photo showing the *Sapyaw* fishing device

Facility Management

After hauling the trap, the cod end of the CARE is placed into a Styrofoam box and supplied with air. The fish are then transported to the holding facility in the village of Matabao. Upon arrival the fish are placed into trays and sorted according to family.

Photo showing fish being sorted

Once sorted, post-larval fish are segregated into separate aquaria to avoid competition and predation. However, fish species with similar characteristics (feeding, behavior, etc.) may be reared together. A local government unit staff, Renato Bagsac, gradually took over the management of the facility with hands on training from the Reef Check Aquaculture specialist. The two worked together to ensure a smooth operation of the facility and its management in partnership with Fredo Cominguez from Feed he Children Philippines and trained by a French team from Ecocean.

Photo showing Fish brought to the facility for sorting

Photo showing the facility main holding tanks

Photo showing fish inside the holding tanks

Photo showing fish inside the holding tanks inspected by the Local Government Staff

Once the fish were large enough, they were then transferred to an offshore facility fish cage. These cages had better quality water and allowed the fish to grow faster and become more acclimatized to the waters around the MPAs.

Photo showing the large fish cages for fish holding after the facility

Pre Feasibility Planning

During the project Reef Check invited a local NGO adept in business and enterprise, the Conservation and Community Investment Forum (CCIF) to facilitate a series of workshops and research activities to develop a business plan or feasibility study for the venture. This was done initially in late 2006 through to 2007. Different partners and participants were invited to the three day business planning workshop.

Marine Protected Areas Surveys

Consultations were held in several villages of Tubigon and at the Municipal Fisheries and Aquatic Resources Management Council (MFARMC) to gain acceptance of the proposed activities (see table in dissemination section). Once the project was explained properly to the whole community they became very interested in taking part in the rehabilitation activities.

Of the five Marine Protected Areas (MPAs) established within Tubigon, the island villages of Bilangbilangan and Pangapasan were chosen as the best sites for the rehabilitation. These sites were chosen because of the superior management of their MPAs, the willingness of local communities to cooperate and the status of the coral reefs and associated habitats (one with high coral cover and one with lower coral cover).

To ascertain the management status of the MPAs, a management rating scheme was applied (www.coast.ph). To further enhance the participation of the local resource users in the rehabilitation activities, local fishers, government officials and partners were trained in coral reef monitoring using the basic Reef Check protocol (www.reefcheck.org) for the Indo Pacific. Baseline assessments were made of both MPAs and the data presented back to the community and used to open a discussion on the management of the MPA (see MPA report). Reef Check Scientists also conducted detailed surveys on the biophysical conditions of the areas (especially fish communities) that were monitored for a before-after and control-impact (BACI) study. During the surveys the Scientists got familiar with the MPAs and identified the experimental stations within the MPAs for the rehabilitation to take place.

Photo showing community consultation about the project

Photo showing community consultation in Pangapasan Village

Photo showing local fisher conducting underwater reef assessment

Photo showing local underwater reef monitoring teams

Restocking the Fish

The Reef Check team was not able to find anyone in the country who was adept with fish tagging, so the Rehabilitation Scientist took it upon himself to study fish tagging. Initially, the fish must be sedated in order for the tagging to take place, so a series of experiments were carried out to determine the optimum amount of quinaldine (Argent Chemical Laboratories) that should be used for the range of species and sizes of the post-larval fishes (see video).

After a series of experiments it was found that using 25 parts per million (ppm) quinaldine was optimal for sedating the different species and sizes of fish in our collection. Fishes were then tagged with fluorescent visible implant elastomer (VIE) (Northwest Marine Technology) to discriminate them from resident fishes in the MPAs.

Many of the collected fishes were first transferred from the facility to the offshore fish cages to be grown further before tagging and subsequent release into the MPAs.

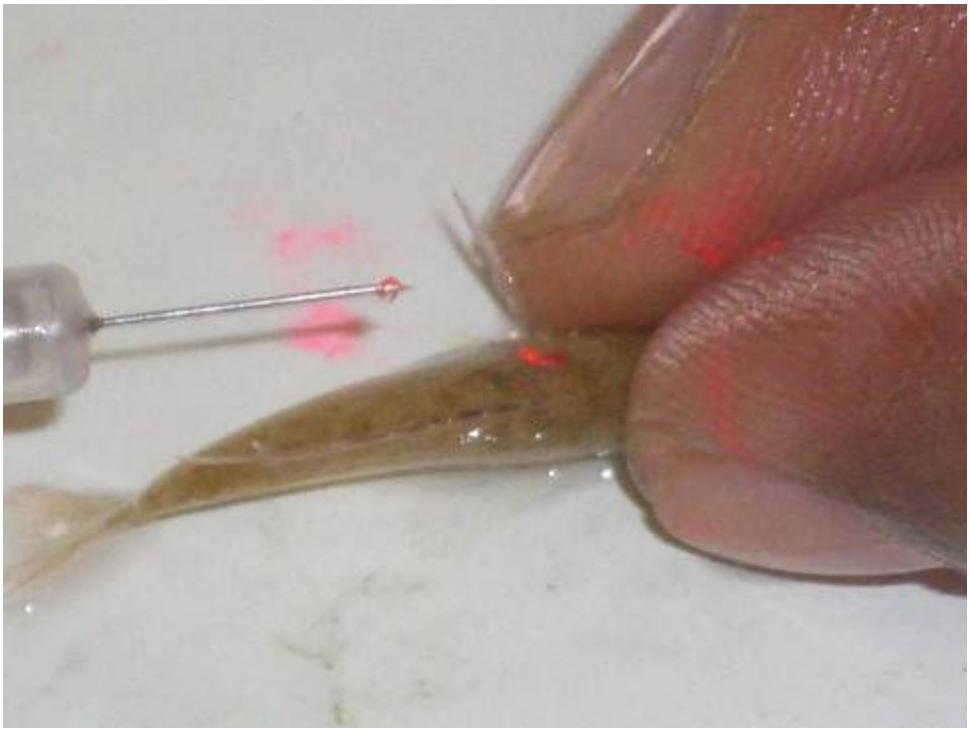


Photo Showing Tagging of a fish

Photo showing Tagged many-lined cardinalfish, 7cm
(*Apogon multilineatus*)

Photo Showing Tagged white-spotted spinefoot, 7.5cm
(*Siganus canaliculatus*)

Photo showing Tagged Indo-Pacific sergeant, 4.7cm
(*Abudefduf vaigiensis*)

Tagged fishes were then placed in cages (1 cu.m.) at restocking depth of 3-5 m inside the MPAs and were conditioned to the site inside the cages for 48 hours. Fish kept in the cages were mainly damselfishes (Pomacentridae) and cardinalfishes (Apogonidae) mixed with few individuals of other different species. The main pomacentrid species was the Indo-Pacific Sergeant (*Abudefduf vaigiensis*) while the main apogonid species was the Many-lined Cardinalfish (*Apogon multilineatus*). The more mobile species like the Dory Snapper (*Lutjanus fulviflamma*) and the White-spotted Spinefoot (*Siganus canaliculatus*) were restocked directly without conditioning in the cages.

Photo showing the small acclimatization fish cage (1 cu.m.) where fish were held for 48 hours prior to release

Photo showing fisher holding fish ready for placing in the acclimatization cage

Photo showing fish being placed into the acclimatization cage

Photo showing fish inside the acclimatization cage

After 2 days of acclimatization, the cages were opened (one at a time) to release the fishes. The fish were observed closely for the first 2 hours using SCUBA. The MPAs were then monitored periodically (up to 15 days so far) for the restocked species and then two weekly trips made to the site to monitor the fish. In an attempt to trace the more mobile species, locally made fish traps were set inside and outside the MPAs to catch the tagged fishes. Local fishers assisted in this study including the visual monitoring of the restocked fishes. Manta tows were also conducted around the MPA area in search of the released fish (the cohorts are easily identifiable).

Photo showing rabbitfishes being released from near the surface (rabbitfishes were not placed inside acclimatization tank)

Results

Planned outcomes	Actual outcomes
Facility operational	Facility operational
High success with an absolute minimum of 12,000 fish collected and monitored	10,807 fish were collected in 860 trap nights
To prototype the technology for the Philippine fisheries situation and offer a "hands on, show and tell" facility which interested parties can visit.	Technology prototyped and variety of visitors from both inside and outside of the Philippines shown the facility and the technology
Increase in quantity of fish stocks within selected MPAs of 10% above baseline	Only a minimal increase found in fish stocks within the MPA (results still being monitored)
Fisheries rehabilitation adopted as best practice within MPA management plans and Local Government CRM plan	Fisheries rehabilitation adopted as best practice within MPA management plans and Local Government CRM plan
Strategy implemented, tested and evaluated	Strategy implemented, tested and evaluated and incorporated into new iteration of CRM plan for Tubigon
At least 10,000 fish restocked in local MPAs with selected fish micro tagged to ensure correct identification	Over 1000 fish micro tagged and restocked in the MPAs
Local staff trained in management of a fish farm	Local staff trained in management of a fish farm, trial shipment attempted and pre feasibility study finalized
Share information to coastal management practitioners and academic institutions to ensure dissemination of results and lessons learned	Peer review journal publication in progress (journal of Fisheries Management and Ecology) and poster being presented in Murcia, Spain in the coming month www.mpasymposium2007.eu (poster attached in the annex)

Fish Collection

A total of 8466 post-larvae (included 180 invertebrates) were collected between January and August, 2007 in both collection sites. In the original proposal it was planned to stop collection by May of 2007, when 12,000 fish were collected, due to the low Catch per Unit Effort (CPUE) during the project this was continued into August. This means that fish should be grown a further 6-8 weeks beyond that period so the restocking was set back slightly until the end of September for some of the fish. Forty-three percent (43%) came from Bilangbilangan area, the other 57% come from Pangapasan with a few nights of collection initially occurring around Ubay island near Pangapasan (see Table below).

The number of fish arriving at the facility and dead on arrival (DOA) was quiet low (ranging from 2.86 to 5.3%) illustrating the good handling of the traps by the fishers.

CARE traps were reliable so as the fishers were present every morning for the catches and no traps were lost.

Table showing the total number of Post Larvae Collected during the project

Family of Fish	Total
Number of "trap nights"	860
Apogonidae	3373
Damselfishes	1743
Snappers / Emperors	648
Scorpionfishes	17
Butterflyfishes	13
Goatfishes	198
Rabbitfishes	1106
Blennies / Gobies	164
Jacks	7
Boxfishes and Porcupinefishes	341
Filefishes and Triggerfishes	20
Fusiliers	76
Pipefishes	45
Squirrelfishes	89
Wrasses	76
Cuttlefishes	12
Barracudas	15
Crabs	34
Eels	11
Squids	134
Others	13
Pelagics	2341
Total Number of fish which were Dead on Arrival (DOA)	331
Total number of fish (excluding pelagic fish)	8,466
Total number of fish collected (including pelagic fish)	10,807
Average per trap / night	9.84

In summary, the average Catch per Unit of Effort per CARE trap during the whole project is 9.84. This amount does not include other fish caught such as pelagic fish (sardines, scads etc), juvenile fish (wrasses and parrots fish mainly) which were

commonly caught in the trap (2341 in total). In terms of diversity 50 different species were collected from 20 families of fish. When the sum of both sites is made, 62.4% of the catch is composed of Cardinalfishes and Damselfishes.

Photo showing siganids in the holding facility (one month old)

Possible factors contributing to the low catch levels

The low catch appears to be related to the poor state of the Tubigon fisheries which may have been further compounded by the high sea temperatures recorded during 2007 in the Philippines, which ranged between 0.5 and 2 degrees Celsius increase over normal temperature for most of the year (coralreefwatch.noaa.gov/satellite/current/crblrg_sstanom_6m.html).

There have been a variety of human errors also that may have contributed to the mortality of the fishes. These include the local fishers removing traps from the sea before dawn. Before dawn, many pelagic fish (like mackerels, scads, etc.) aggregate around the fish traps trying to consume the post larvae inside the trap. If the trap is lifted before dawn these fish will become trapped inside the net and consume some of the larvae while in transit back to the facility. Fishers were advised to not lift their nets prior to dawn for the last months of collection.

In late June it was also noticed that the local fishers were not putting separate traps on separate moorings. Apparently, some moorings were lost to theft and the fishers improvised by attaching the fish traps together on a single mooring. This sampling

strategy is much less efficient than having a separate mooring per fish trap. This was also rectified in the last two months of the collection.

Facility Management

The base of operations used is a facility which was funded by the Japanese Government as a grouper hatchery in 1997. The facility was used for several years, but was abandoned in the years 1999 – 2005. In 2006 it was modified and upgraded to be a holding facility for post larvae capture and culture.

Photo showing facility prior to upgrade

Early in November 2006, the project team began upgrading the facility to receive fish post larvae. Air and water systems were put in place and new holding tanks installed, as well as a backup system for air, water and electricity. A second seawater pump (3 HP) was installed since the existing pump (1 HP) was not powerful enough to pump the required amounts of water into the facility. The "old" pump (1HP) was then used to re-circulate the water from the holding tank to a sand-pebble filter tank, whereas the new pump (3HP) was used to pump seawater when the sea was at high tide.

Tank and aquarium water renewal was set at 5% change per hour from the holding tank (9 cu.m.) which enabled the facility to pump sea water only once per day (the location of the facility is in a long tidal flat which is immersed only 1-2 times per day) and during low tide no pumping can take place. The facility manual describes in detail the management of the facility and its day to day operations (in Annex) and will enable staff with a minimal technical background to manage the facility.

Photo showing the facility operational

In a facility like this, mortalities are expected, especially for fish post larvae which have not yet undergone their metamorphosis into juveniles, so a mortality of 20% was factored in to the project design (in project deliverables to collect 12,000 fish and restock 10,000). Unfortunately, mortality was much higher than this and approximately 80% fish mortality occurred in the facility for the duration of the project.

The following factors contributed to the mortality:

Feeds

a) Feeding routine. Most of the collected and reared fish in the facility is from the family Apogonidae (40.9%). This family of fish has low survival rate, which may have been due to a poor feeding routine. Being nocturnal fishes, they may not be suited to being fed in the day. We have also noted that the feeding time was too short.

b) Inappropriate food. Initially, food pellets were brought in from France for the facility. However, due to the import expenses, local sources of food were tried. The required grain size for the fish is very small and only one supplier of such feed was found in the Philippines. The food appeared to be good initially but as time carried on it deteriorated considerably and appeared powdery. This led to more difficult weaning and fish appeared thin and perhaps more susceptible to diseases.

High temperature

Unfortunately, the facility has a poor ventilation configuration and can get very warm inside. The large tidal flat from which the facility sources its water is shallow and the seawater can get very hot in the summer. Therefore, elevated temperatures coupled with a poorly designed facility compounded the heat stress on the fish (facility seawater reaching temperatures of 31°C at times).

Diseases

There were three peak mortalities during the project lifespan. One was at the end of February (508 mortalities), one at the end of May (412 mortalities) and one at the beginning of June (310 mortalities). The mortality was very high in particular in one tank (tank # 3). Based on the rate of mortality and the way the mortality occurred, it appeared to exhibit signs of bacterial infection. When the infection appeared, those remaining fish were immediately removed from the tank and most recovered over several days. Diseases could have been acquired through the following:

a) Sometimes the facility manager would keep adult fish and crustaceans in the rearing tanks with the post larvae (despite several reminders not to do so). The adult fishes and crustaceans could likely be the source of the pathogens.

b) The process of cleaning the brine shrimp was not followed. It was taught to clean the shrimp in fresh water to kill the germs on the eggs. For some reason, this step was not practiced consistently in the facility which may have led to the introduction of the bacteria into the facility.

Seacage design

Four hundred and fifty two fish died in the seacages prior to fish tagging. The fish cages on hindsight may not have been deep enough (ranging from 0.3m to 1m depth). The shallow cages resulted in fish being stressed as the surface waters became very warm. Fishes in the shallow cages also are unable to avoid surface pollutants. Flotsam and murky water were observed to wash through the seacages. This system was not used in the final rehabilitation activities and mortality was reduced considerably (tagging and handling mortality ~ 2%).

Mortality after tagging

Directly after tagging, a further 815 fishes suffered mortality. This appears related to the added stress of the tagging, compounded with the shallow fish cages and warm waters. When the tagging was conducted in the facility only 6 (out of 500 plus) fishes suffered mortality due to tagging itself. The most susceptible to mortality after tagging was the small (~3 cm) damselfishes (Pomacentridae).

In summary, there was a mix of human error and lack of follow up training and quality control as well as poor planning (sea cages and lack of available feeds). All were compounded by the increased seawater temperatures leading to the very unfortunate level of 80% mortality prior to the fish reaching the rehabilitation. The project management team, however, kept learning through the process, as this was the first time the team had tried something like this. At each step we had to adapt quickly, but overall the team were satisfied that we learnt from each problem and adapted as quickly as we could to each situation as it arose.

Business planning

A two day pre-feasibility planning workshop was conducted as part of the project activities. This component planned to focus on the possibility of generating revenues for the facility and post larvae collection activities in order to sustain the venture and rehabilitation into the future.

Due to the very low numbers of larvae being collected and the low levels of high value species, both for local aquaculture and international marine ornamental markets the business venture is clearly not feasible. Another drawback is the presence of a local wild fishery for marine ornamental fish. This local fishery get paid very low prices for wild caught fish, so aquaculture fish with considerable overheads are far too expensive to compete with those caught in the wild.

Local fishers collecting marine ornamental fish have very limited overheads and can immediately ship their fish to the international markets. With $0.02 per fish for some of the more common species, it was very difficult for the facility to be competitive, given the minimal volumes of fish being caught with the fish traps.

A trial shipment of 283 fish was, however, prepared and the whole process of export facilitated to a national marine aquarium in France (www.nausicaa.fr) to further understand the costs and resources required for export in the future, when feasible. The Shipment succeeded with only 6% mortality during the 44 hour journey from Cebu, Philippines, to Paris, France and onto the North of France. The immense paperwork and administrative requirements were well managed and the shipment considered a success with only 6% mortality.

Unfortunately the business planning ran through the actual economic figures behind the post larvae as a business proposition and showed that the collection and sale of post larvae would not be feasible. The conclusions from the planning showed that with the low levels of fish capture the business would not be feasible, however the facilitators stressed the “start up” nature of the technology and that it would still take several years of investment to get it to be commercially viable.

The facilitators stressed that if fish could be collected in larger numbers and with more commercial species it could be very viable for both the local fish market for aquacultured fish and ornamental fish. It was agreed by the team that the commercial application would require a percentage of the fish to be returned to the MPAs of the municipality as “environmental tax” to continue the rehabilitation activities.

Surveying MPAs

Both MPAs used identified for the experiments were assessed using an MPA management rating system (www.coast.ph). Based on the management criteria

Bilangbilangan is a level 4 MPA and Pangapasan is a level 3 MPA (as of June 2007). The Bilangbilangan MPA is a 10.5-hectare marine sanctuary and Pangapasan is a 7-hectare marine sanctuary. A local reef monitoring training was conducted for reef monitoring and from 23 participants seven fishers were able to pass the classroom and field exercises (getting 80% of the Reef Check indicator organisms correctly identified).

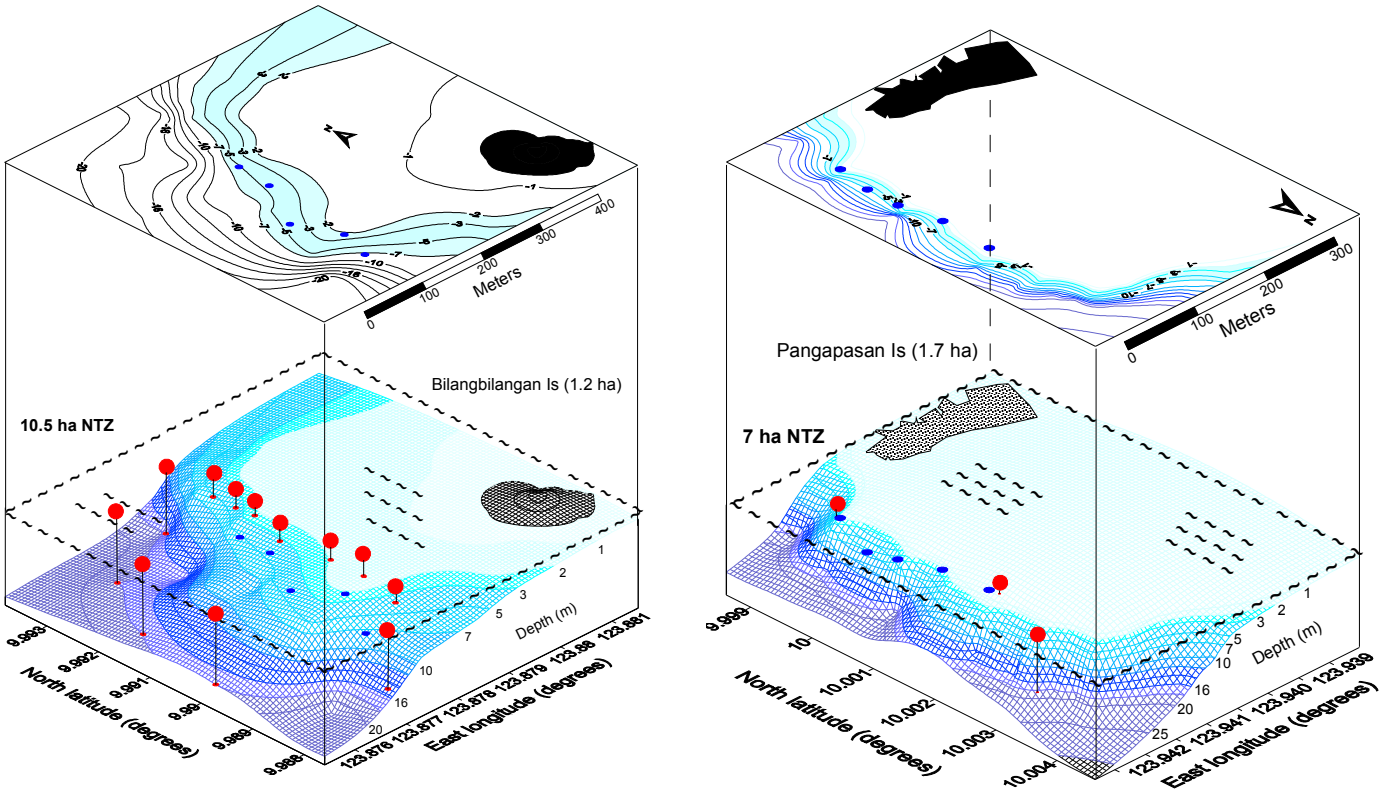
Initial biophysical surveys showed the following biophysical components of the MPAs (March, 2007).

Major substrates (percentage cover) ascertained through transect

Substrate	Bilangbilangan (old MPA)	Pangapasan (new MPA)
Hard coral	53.87%	18.42%
Algae	00.08%	18.00%
Rock	16.60%	32.92%
Sand	26.28%	22.58%

Dominant fishes (per square meter)

Fish Family	Bilangbilangan (old MPA)	Pangapasan (new MPA)
Apogonidae	0.07	0.03
Labridae	0.09	0.15
Serranidae	0.02	0.00
Pomacentridae	2.55	0.64



Three dimensional models of the study sites in Bilangbilangan (left) and Pangapasan (right).

Depth profiles show gentler reef slopes in Bilangbilangan than in Pangapasan. MPAs, which are far larger than the islands, are enclosed by buoys shown in red dots. The deeper buoys of the Pangapasan MPA have been lost, which were ran over by passenger boats that navigate very closely to the MPA. Blue dots on the reef are the actual survey stations for substrates and fish community. Stations in both MPAs were selected where the tagged fishes were also acclimatized and subsequently released.

Fish Restocking

- As at July 5, fish stocks totaled 2,003 individuals which were mostly apogonids, damsels, rabbitfishes, snappers and emperors of which, 1,745 fishes were in the seacage and 288 were still in the hatchery
- A total of 478 fishes were released in the MPAs and about 20% of those were still seen after 15days
- In Pangapasan (new MPA), 67% of *A. vaigiensis* were seen after 15days
- In Bilangbilangan (old MPA), 42% of *A. vaigiensis* were seen after 15days
- Snappers (*Lutjanus fulviflamma*) stayed in the area of release for more than 3 hours but were never seen again within the 15-day monitoring period
- Rabbitfishes (*Siganus canaliculatus*) stayed in the release area inside the coral reef MPA for about one hour only and commenced swimming into the shallower *Sargassum*-seagrass zone

- No tagged fish was caught in the fish traps that were deployed inside and outside of both MPAs although fishers have been offered an incentive if they find the fish and document the tagged information
- Final restocking in Pangapasan and Bilangbilangan took place in September 18 and 19, respectively. Another 527 fishes were released in the MPAs
- Monitoring of the released fishes are continuing and the final survey of the fish community in the MPAs will be finished by end of September
- Overall, a total of 1,005 fishes (478 and 527) were released in the two MPAs of Tubigon

Community interaction during the fish restocking activity held in August

Fish ready for release

Local officials snorkeling while the fish are released

Fish release under water

The table below summarizes the data for the restocking activities:

Seacage data			7-30 July 2007		4,5,10 August 2007		4-21 August 2007	
Genus (Family)	species	Size_cm (S.D.)	Tagged		**Restocked**		Recovery/seen after 15 d	
			count	% of total	count	% of tagged	count	% of restocked
Abudefduf	*vaigiensis*	4.87 (0.77)	357	27.61%	**170**	47.62%	94	55.29%
Siganus	*canaliculatus*	7.71 (1.30)	349	26.99%	**115**	32.95%	0	0.00%
Cheilodipterus	*artus*	9.52 (1.22)	147	11.37%	**11**	7.48%	0	0.00%
Pomacentridae	17 spp	4.28 (1.52)	94	7.27%	**30**	31.91%	5	16.67%
Neopomacentrus	*violascens*	6.33 (0.96)	77	5.96%	**30**	38.96%	0	0.00%
Lethrinidae	6 spp	8.92 (1.64)	66	5.10%	**35**	53.03%	0	0.00%
Apogon	*multilineatus*	6.13 (0.52)	66	5.10%	**34**	51.52%	1	2.94%
Lutjanus	*fulviflamma*	9.30 (1.63)	36	2.78%	**36**	100.00%	0	0.00%
Others (mixed species)			101	7.81%	**17**	16.83%	0	0.00%
	Totals		1293	100.00%	**478**	36.97%	100	20.92%

Hatchery data			14-17 Sept 2007	
Family	**Total**	Major species	Count	Size_cm (SD)
Siganidae	**223**	*Siganus canaliculatus*	188	6.90 (1.63)
Pomacentridae	**230**	*Chromis viridis*	64	3.76 (1.24)
		Dascyllus aruanus	66	3.60 (1.11)
		Pomacentrus moluccensis	17	4.97 (1.42)
		Small damselfishes	58	2.94 (0.23)
Apogonidae	**28**	*Apogon bandanensis*	17	6.57 (1.13)
Lutjanidae	**13**	*Lutjanus fulviflamma*	12	5.76 (0.58)
Others	**45**			
Total	**539**			
(Mortality)	**12**	(6 from tagging, 6 from packing)		
Restocked	**527**			

Photo showing tagged rabbitfishes found among seagrasses near the MPA

Photo showing tagged rabbitfishes just outside the MPA boundary

Photo showing tagged snapper inside the MPA

POST PROJECT OUTCOMES

The logic framework presented in the full proposal additionally included a final column where predicted values of post-project outcomes were to be provided.
Describe any progress towards achieving these post project outcomes at this time

Predicted Post-Project Outcome	Actual Post Project Outcome
Facility operation with local management in place	Facility still operational with local management team trained and in place. Local sources of funding are being reviewed at present to continue operations into 2008 and beyond.
Local staff capable of managing a local facility with revenue created through the development of a business plan for the operation. Facility running financially sustainable with sale of post larvae fish for local aquaculture facilities and export of ornamental fish financing the maintenance of the facility and continued restocking activities.	Two local staff (one from the Local Government) and one from the local Non Government Organization the Feed The Children Philippines are capable of running the facility
Center becomes an educational hub for local schools, academic institutions and government and non government organizations and fishers to further enhance their education and assist with research and the rehabilitation technology is already replicated in at least 1 other area in the Philippines and / or Indonesia	Center has become a hub but not quite for what was envisioned. Local schools are now very interested in working with the partners to develop a local school aquarium and this is being explored further.
Fish diversity and quantity increases continued in local MPAs with at least a 30% increase over baseline in all local MPAs	Initial research shows that there has been minimal fish diversity and quantity increases due to the fish releases.
Fisheries rehabilitation strategy in coordination with a network of MPAs adopted by the Local Government Unit and local institutions adopting fisheries rehabilitation in coordination with the fish farm facility	The Local Government Unit has adopted the whole technology and the rehabilitation activities and allocated budgets for 2008 for continued activities.
Successful rehabilitation activities adopted, coastal management plans funded and implemented with local financial sources	Local sources of funding are being sourced out for the continued rehabilitation activities.

Fish survivability, general habitat and fish assemblage data tracked in local MPA network with the assistance of local community and local institutions monitoring teams beyond the lifespan of the project and results continually integrated into the management and possible expansion of the network of MPAs	Local Reef Monitoring teams trained in both project locations and annual Reef monitoring plan and assessment activities adopted at the municipal and village levels
A viable community and local government enterprise operational, funding the sustainable rehabilitation activities and expansion of the MPAs with limits set to the amount of post larvae collected from the wild.	Initial framework for the post larvae collection presented to the project steering committee and policy making body of the municipality the Sangguniang Bayan for adoption into the new CRM plan for 2007 – 2012 being prepared at present.
Results presented in such a manner that further research, experiments and rehabilitation systems can be replicated, offering a best practices framework upon which to build and for local replication within the facility.	Results are being prepared for scientific publication and poster presentation to happen in Murcia, Spain on the technology refined under NFWF funding. Results are being organized for statistical analysis and for journal publication. Rehabilitation Scientist may present results at the International Coral Reef Symposium in Fort Lauderdale, Florida in 2008.

Other activities beyond the project scope

As the project was implemented a group of researchers form the University of Edinburgh, United Kingdom contacted the project implementers and asked if they could add onto the project and conduct their own complementary experiment on fish post larvae.

The SAFE system (Sound Attracting Fish device-Ecofriendly)

Dr. Stephen Simpson of Edinburgh University (www.biology.ed.ac.uk/projects/projectnemo/) is also studying fish post larvae, but looking at the use of sound as an attractor for post larvae fish. Therefore, a unique partnership was developed and the NFWF work in Tubigon was offered as a counterpart and location for the University of Edinburgh for the dissertation research of Adel Heenan with co-financing from the French Agency of Innovation (OSEO).

To enhance the collection of post larvae, the CARE device had a separate sound device added to see if fish collection could be improved. Interestingly, despite five weeks of collection using the sound devices in the Philippines there was no significant

improvement in catch with this modification (catches were doubled in Australia using the same device). Data are being analyzed further by the researchers, but initial results suggest that there is a fundamental difference between the Philippine waters and Australian waters where this study was also conducted.

An initial hypothesis is that the sound may attract more pelagic fish to the collection devices which in turn scare away the post-larvae. Another hypothesis is that the area is just heavily overfished and that sound has no more effect than light because there are so few post larvae recruiting. A third hypothesis is drawn from the situation that the town is in the middle of a busy navigation route for passenger ships, with traffic almost every hour. This could effectively scare off the post larvae or even make them hard of hearing to the more subtle reef sounds. More research is definitely needed into this interesting phenomenon and will be repeated in Australia in late 2007 and again in early 2008.

Will there be continued monitoring of post project outcomes beyond the life of this grant?

Reef Check Philippines, Feed The Children Philippines Inc and the Local Government Unit of Tubigon will continue with the monitoring activities within the MPA (results need to be observed over many months). Local reef monitoring teams in both MPAs will also be able to carry on regular annual surveys. The Local Government Unit and in particularly the Honorable Mayor and his First Lady and Vice Mayor of the municipality (seen below) helped assist in the actual restocking and have committed to continue the restocking activities and allocate budgets in 2008.

Honorable Vice Mayor releasing the fish into the MPA

Are there adequate resources (staff and funding) for continued evaluation and monitoring? If not, briefly, describe the additional resources needed.

The Local Government Unit of Tubigon has agreed to fund the survey activities of the local fishers, whilst Feed The Children Philippines and Reef Check Philippines will

provide limited technical assistance through its Marine Aquarium Market Transformation Initiative project under the Global Environment Facility to carry this through.

Describe any revisions in the indicators, methods and data that may be needed for post project monitoring.

All the indicators, methods and data are consistent for the post project monitoring.

DISCUSSION AND ADAPTIVE MANAGEMENT

Lessons learned and transferability

Capacity Building

Capacity building is a difficult process and should include training, coaching, evaluation and copious amounts of follow up. When the manager of the facility was proclaimed to be fully trained, he was left to manage the facility with minimal inputs from the other staff. It appears that this turn over of responsibility is linked directly with the mortality in the facility.

Although the staff member was well trained it appears he did make some of the mistakes which led to the large mortality, such as not following the manual guidelines. The keeping of crustaceans within the facility should not have been allowed. Information management systems were not being kept properly as well. It is now realized that the three months hands on training was not enough and a regular daily follow up was needed by the team. The facility management guide has contributed to setting the operations of the facility and setting a clear operation system for the facility.

Likewise it appears that the fisher collectors were not well managed. Having been trained not to do so, the local fishers began to haul in their nets before sunrise from the sea, leading to the large numbers of pelagic fish being caught in the first few months of the project. There was no feedback to the management that the mooring buoys had been stolen or that the fishing devices were being strung together at night. Despite an intensive training there was a considerable backslide on the part of the fishers. Although seen as only minor discrepancies, they have contributed considerably to the lack of collection and the huge mortality.

These seemingly small lapses had a significant impact on the success of the project and are important to consider. Although this was a "capacity building" project to develop local fishers and facility managers, there is a need for the management to have careful monitoring to ensure that the reasons behind having information systems in place and maintenance protocols are understood properly. This is one of the dilemmas with capacity building and timing the point at which you turn over responsibilities to local partners. On the negative side the project incurred considerable mortality, however on the positive side the technician has learned some hands on lessons in how to deal with major mortality incidents within the facility.

MPA management

Although both the MPAs were assessed as being well enforced (on paper) it appears that only Bilangbilangan is being well managed. The MPA of Pangapasan has a lot of problems which require further work. The hands on approach used in the project, however, enabled the local fishers themselves and village officials to be involved and

therefore see for themselves first hand that the sanctuary is not achieving its main objectives of fish biomass build up, despite being close to a decade old.

Good management and enforcement can lead to recovery of fish and habitats within MPAs and monitoring (of management activities and biophysical conditions) is essential in evaluating the status of MPAs (as many MPAs are established without further monitoring).

Fish restocking with the species used in this study is so far looking better in the newer MPA (Pangapasan) than the older more established MPA. Another lesson learnt has been that fish are even more mobile than we thought and that the restocked fish went outside the bounds of both MPAs, even coral reef fish like the Indo-Pacific Sergeant (*Abudefduf vaigiensis*), so MPAs need to be considerably larger.

Due to the project inputs the villagers of Pangapasan have realized that their MPA requires a full evaluation and enlargement to include the coral reef associated ecosystems such as the mangroves and seagrass beds that fringe the MPA. Fish appear to be moving actively across the reef into these areas and local fishers are targeting this daily migration which in turn is reducing the biomass of fish within the MPA.

The project also found that fish should not be just taken from the fish cage or facility and directly released into the MPA. An acclimatization step is needed prior to the release of fishes and 24-48 hours appears to work. The time is enough for the fishes to relax and get familiarized with the immediate surroundings but is short enough to get too attached to their holding cage to stay.

Once fish have been acclimatized their release should be done by slowly opening the cage and just letting the fishes swim out at their own pace. Observers must avoid excessive movements as fishes are still very wary and may swim in avoidance, instead of being able to discover the immediate environment. Newly released fish need to do some orienteering before they swim in their desired direction.

This study reconfirms the various studies regarding the Philippines (Green et al, 2003) that fisheries are in a very poor state. Although the collection of the post larvae and restocking has been difficult in fisheries such as those of Tubigon, these areas are the ones which require the work on restocking and not pristine areas with plentiful supplies of larvae.

A small change in the sea temperatures for the year 2007 had a lot of impact on the stress on the fish, both in the facility and in the sea cages and in the initial collection. It is hoped that this year was just an anomaly.

Although we had some problems in fine tuning the fish holding system and losses to mortality, it is important to stress that this is one of the first times in the world that post larval fish have been grown and then released into MPAs. There is still substantial work to be done on this technology and restocking in general, but with a limited budget and

focused work we have proven that this technology can be brought down to the level of the resource users (fishers and local government staff) and be utilized. In the project assessment workshop held in Tubigon in the middle of September 2007, the whole project implementation team and partners agreed that the project was a great success and that our activities should be continued in the coming years.

To what extent did the evaluation and monitoring activities for this project inform your organization about effective conservation practices, and what lessons were learned from an evaluation perspective?

Restocking of fish is a very new tool for fisheries management which is perhaps only applicable in areas which have already quite a high and successful coastal management.

The sizes of the MPAs in this study (7-10 hectares), which are typical in small island settings, are clearly not enough to contain many of the species that were restocked. In the future, Reef Check will only encourage the establishment of MPAs which are at the absolute minimum 20-30 hectares in size.

Likewise it reinforces the fact that larger MPAs should be established, and/or different zones of the marine environment should be protected as well (marine sanctuaries are commonly coral reef areas only). These larger MPAs and/or network of smaller sized MPAs should protect the fisheries through the whole of their life cycle and as they move form habitat to habitat (seagrass to mangrove to coral reefs, etc.)

Fisheries restocking appear to be more applicable for newly established MPAs which have a good design and clear law enforcement. Fish species should be restocked into their appropriate habitats as well (e.g., siganids in seagrass-algal zones, damselfishes in coral reef areas where there is available habitat).

The same as with all coastal management tools in the Philippines, the participatory approach was essential to the process. Likewise the involvement of local political leaders was an enlightening experience for all concerned.

The Mayor is now very proud of the restocking activities in his municipality and wants to carry on the activities. It also gave him a good understanding of some of the problems besetting the coral reefs within his municipality. Within three weeks of the restocking activity the Mayor called a round the table discussion on how to reduce further the incidences of illegal fishing within the municipality with local and national law enforcement agencies. He has also began to interact with his peers in the political leadership in the Province of Bohol. This will help to disseminate to the political leaders the state of the resources and also to offer some optimism that something can be done to rehabilitate fish stocks in the province and surrounding areas.

Honorable Mayor Atty. Luna Piezas and First Lady of Tubigon releasing fish into the MPA

Based on these lessons learned, what are your organizations next steps?

A plan is in progress to significantly upgrade the facility to become a children's scientific laboratory and mini aquarium. There are close to 350,000 school children within 80 km of the facility and with the initial enthusiasm the project partners and local school children have shown, there appears to be a clear role for the facility to help educate school children on the plight of the coral reefs in Tubigon and the Philippines as a whole. Future activities of the center will focus around developing post larvae and also focus on educating the next generation about the plight of Philippine coral reefs. The NFWF grant has enabled the project team to realize the potential of the tool.

The next steps of the organization are to conduct a refresher course for the fishers and the facility manager and look for counterparts and funding to establish the post larvae facility as a children's aquarium with our partners Ecocean, Feed the Children Philippines and the Local Government Unit of Tubigon.

DISSEMINATION

The project has conducted a large number of different dissemination activities during its life span. These are documented in the table below.

Table summarizing the extent of information communicated to the general public

Location	Activity Date/s (2007)	Activity	Participants		Actual Outputs of the activity
			Male	Female	
Tubigon, Bohol	January 15-17th	Workshop on Fish Larvae Collection and Rehabilitation (1st day)	16	7	Assessed progress and prepared implementation plan for the project in Tubigon with local fishers and key partners
Tubigon, Bohol	January 23rd	Resource Management meeting	11	1	Discussion on the Status of the MPAs in the municipality, CAMPC Action planning
Tubigon, Bohol	February 1-2nd	Project management steering committee meeting	7	2	Reviewed plan, discussed implementation activities with partners
Pangapasan Island and Bilangbilangan island	February 3-4th	Presentation of project concept to local communities	21	5	Presented to local fisher families the proposed activities
The University of Philippines Marine Science Institute, Diliman	February 14th	Restocking of Post-larval Reef Fish in MPA's as a Rehabilitation Strategy	12	10	Presentation of the design of MPA and elicit comments and suggestions
Villages of Pangapasan and Bilangbilangan, Tubigon	March 12-23rd	Conducted Baseline survey on MPAs within Tubigon	2	-	Initial baseline data collected
Tubigon	March 24th	Initiated fish	2	-	Facility manager

	– 4th April	tagging in facility			assisted in tagging
Tubigon	April 25-26th	Business planning workshop	13	6	Prepared Pre feasibility study and proposed trial shipment activities
Tubigon, Bohol	April 27th	Project steering committee meeting	6	2	Review of project deliverables and activities
Tubigon, Bohol	April 30th	RC Training MPA assessment and Management	19	2	Resource Monitoring training
Tubigon, Bohol	May 1st	Tubigon MPA Management and Reef Check Monitoring Training	19	2	MPA Management and Reef Check presentation and training
Fish holding facility, Matabao, Tubigon	May 1st	Trial shipment prepared, packaged and dispatched to France	5	-	Prepared trial shipment and sent to France
Pangapasan Island	June 12th	Video and presentation to village during the annual fiesta program	27	20	Discussion on the need to rehabilitate and manage the marine sanctuary
Tubigon, Bohol	June 18 - 20th	Local Reef monitoring team training	18	5	All attendees completed the training with seven receiving recognition and identity cards as proficient Community Reef Checkers
Tubigon, Bohol	July 25th	Presentation to the Sangguniang Bayan of Tubigon on the results of the underwater collection with University of Edinburgh	13	5	PhD student Adel Heenan presented the state of collection using the SAFE technology
Tubigon,	July 17 –	Fish tagging	4	1	Local government

Bohol	30th				official and Feed The Children staff joined fish tagging activities
Tubigon, Bohol	July 1 – August 7th	Fish surveys	6	-	Local Government staff, Feed The Children staff and Local fishers joined fish surveys
Tubigon, Bohol	July 12th	Meeting with newly inaugurated Mayor Atty. Luna Piezas and Sangguniang Bayan members (local legislative council)	8	2	Presented the project activities to date with the newly inaugurated Mayor of the municipality, met with a warm welcome
Pangapasan and Bilangbilangan islands	August 3rd	Community consultations	71	33	Updates of the project presented to local fishers and their families and members of the resource assessment teams
Tubigon, Bohol	August 5th	Restocking 1 in Pangapasan and Bilangbilangan)	4	-	Restocking of 300 fish
Tubigon, Bohol	August 10th	Major restocking with partners and local fishers	27	9	Restocking of fish and release into the MPA
Tubigon, Bohol	August 10th	Restocking of 130 fish of different species	3	1	Restocking and release into the MPA
Tubigon, Bohol	September 14 –17th	Fish tagging	2	1	Local government staff joined the fish tagging
Tubigon, Bohol	September 18 –19th	Final fish restocking	3	-	Restocked 527 fishes in Bilangbilangan and Pangapasan MPAs
Tubigon, Bohol	September 20 – 27th	Final surveys of fish communities	3	-	Surveys of resident fishes

		in Bilangbilangan and Pangapasan MPAs with monitoring of restocked fishes			and restocked fishes
Pangapasan and Bilangbilangan islands	September 28th	Community consultations	36	10	Final project updates presented to the respective barangays with recommendations for MPA management

The partnership of Reef Check and Ecocean is also presenting in the MPA symposium in Murcia, Spain in October 2007. The poster to be presented is attached. The Reef Check rehabilitation scientist is also in the process of applying to present the results at the upcoming International Coral Reef Symposium to be held in Fort Lauderdale in Florida in 2008. As mentioned previously, the scientific paper for journal publication will be prepared and finalized in the coming months.

NFWF ADAPTIVE MANAGEMENT

The initial help of the administrator Sarah Cabell was very informative and helped us secure the final grant, so we really appreciated that assistance in 2006.

The initial fund release took a considerable amount of time, considering the project was supposed to start in September 2006, arriving eventually in Mid January. However, due to the match funding we were able to continue with activities albeit at a slower pace.

It appears that NFWF has had some considerable moving around in the last year including project administrators; this is understandable given the change in location and therefore staffing.

The NFWF fund enabled us to explore a very interesting concept, from which we learned a lot. Hopefully, the facility will carry on successfully in coming years and we will thank NFWF for that, the whole project team and the partners in the project!

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Annexes

I. Post Larvae Capture and Culture. Facility Guide for the Matabao, Tubigon, Bohol Larvae Education Center

II. Post Larvae Capture and Culture. Facility Guide *Visayan version*

III. Using post-larvae fish to boost Marine Sanctuary recovery: unrealistic or in perspective? A poster presentation by Ecocean and Reef Check

IV. Sound. The essential navigation cue for young reef fishes to find their way home. A poster presentation by Stephen D. Simpson, Ph.D., University of Edinburgh

V. Marine Sanctuary Management Report of Bilangbilangan and Pangapasan (Tubigon, Bohol, Philippines)